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RAPID: Effect of a Very Low NAO Event on the Abundance of the Lipid-Rich Planktonic Copepod, Calanus Finmarchicus, in the Gulf of Maine

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Preview of Award 1235920 - Final Project Report

Cover

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Recipient Organization:	University of Maine
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Submitting Official (if other than PD\PI):	Jeffrey Runge Principal Investigator
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Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Jeffrey Runge

Accomplishments

*** What are the major goals of the project?**

1. Test the hypothesis that a distinctly lower abundance of the planktonic copepod, *Calanus finmarchicus* in the Gulf of Maine follows the occurrence of very negative winter phases of the North Atlantic Oscillation (NAO). In 2010, the station-based winter NAO index was -4.64, even more intense than the negative (-3.78) 1996 NAO winter index. If a two-year lagged relationship between very negative NAO winter indices and *Calanus* abundance in the Gulf of Maine is valid, cooler water from the Labrabdor Sea should replace Atlantic Temperate Slope Water in the GoM in 2012, inducing a major climatic ecosystem event on the New England shelf, one manifestation of which would be dramatically lower *Calanus* abundances in the Gulf of Maine basins.
2. Collect data on demography, abundance and characteristics of body size and composition of the *Calanus finmarchicus* in Wilkinson Basin during a period of extreme warming in the Gulf of Maine. These date will provide evidence for development of hypotheses about the sources and fate of C. finmarchicus in the Guf of Maine in the context of climate forcing of the region's coastal ecosystems.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: This reporting period covers the no cost extension of the award.

1. We completed analysis of plankton samples collected at two time series stations, the Coastal Maine Time Series (CMTS) station in the Maine Coastal Current off the Damariscotta Estuary and the Wilkinson Basin Time Series Station (WBTS) in Wilkiinson Basin.

2. We have published or submitted 4 research articles related to the subject of the award. One (Runge et al. submitted) report and interprets the results of the sampling activities in the Gulf of Maine (Wilkinson Basin) in 2012-13 that were the focus of this RAPID award.

3. The dataset from the Wilkinson Basin Time Series Station between April 2012 - May 2013, the collection of samples from which was fully supported from this award, has been submitted to the NSF BCO-DMO for archiving. BCO-DMO will also ensure that these data are permanently archived at the National Oceanographic Data Center (NODC).

4. The results of the award activities are the foundation for a new research proposal, to be submitted to the NSF BioOce proposal, to investigate a new hypothesis about the mechanisms sustaining persistence of this key planktonic species in the Gulf of Maine under rapid warming in the region.

5. The results were presented at the Ocean Sciences Meeting held in Honolulu in Feb. 2014.

6. J. Runge served as co-chair of the NERACOOS/NROC Ocean and Coastal Health Committee and a co-chair, with M. Cote (US EPA) and Brian Thompson (Conn. Dept. Env. and Energy Protection), of the Integrated Sentinel Monitoring Project (http://www.neracoos.org/sentinelmonitoring). This project is a multi agency and institution effort to coordinate observing of the Northeast US shelf ecosystem during climate change. Because it is the foundation of the Gulf of Maine pelagic food web, C. finmarchicus has been designated as a sentinel variabile for future observing activities.

Specific Objectives:

1. Conduct time series sampling (1-2 times per month) at a prescribed fixed station in Wilkinson Basin using standard protocols for monitoring Calanus in NW Atlantic waters.

2. Sample C. finmarchicus along a transect in Wilkinson Basin during a research cruise on the R/V Cape Hatteras in Sept-Oct., 2012.

3. Analyze samples for abundance of C. finmarchicus life stages and for body size and lipid volume of stage CV. Conduct a preliminary analysis of carbon and nitrogen and fatty acid composition of stage CV.

4. Write up results of analyses with respect to hypotheses about factors controlling the sustained high abundance of C. finmarchicus in the Gulf of Maine

Significant Results:

C. finmarchicus abundance in Wilkinson Basin remained at high levels in 2012, contrary to predictions based on the occurrence of the very low 2010 NAO. The fixed station time series and the transect across Wilkinson Basin in late September both show stage CV abundances that make the GoM among the regions with the highest abundances (in terms of numbers m-2) across the subarctic range of the species.

A new hypothesis has been developed to explain the mechanism sustaining C. finmarchicus in the Gulf of Maine. The processes involved include supply from Canadian sources from the Scotian Shelf, local egg production, southwesterly transport of growing copepodid stages in the cold and phytoplankton-rich Maine Coastal Current, and accumulation of the dormant, preadult stage CV in deep water, particularly Wilkinson Basin in the western Gulf of Maine. The magnitude of *C. finmarchicus* abundance in the southern and western Gulf of Maine during the succeeding spring is expected to vary according to the match or mismatch of the temperature-dependent emergence from dormancy in late winter with the timing of the winter-spring phytoplankton bloom in Wilkinson Basin.

Key outcomes or Other achievements:

1. Successful completion of a time series in Wilkinson Basin, the major center of C. finmarchicus abundance in the western Gulf of Maine, during 2012, the warmest year on record in the Gulf of Maine. This sampling effort fulfills the RAPID goal of providing funds for quick-response research on significant and unanticipated natural or anthropogenic events.

2. The research disproved a longstanding prediction that dramatic change in abundance of C. finmarchicus in Wilkinson Basin is correlated with the state of the North Atlantic Oscillation

3. A new hypothesis explaining the mechanism sustaining C. fimnarchicus in the Gulf of Maine during climate change was introduced in a research article to be published in the Journal of Plankton Research. The hypothesis repesents a specific case of the general hypothesis that *the interaction between upstream source supply, advection and local production contributes significantly to persistence of planktonic populations on continental shelves despite environmental changes associated with climate warming.*

*** What opportunities for training and professional development has the project provided?**

This project represents a 1-year RAPID award with an additional 1-year no cost extension. It contributed to the development of reserch skills in sample collection and analysis for UMaine research associate, Cameron Thompson. University of Maine undergraduate students participated in sample collection at the Coastal Maine Observing station and received training in methods in zooplankton ecology and basic principles of biological oceanography.

*** How have the results been disseminated to communities of interest?**

The results will be published in the Journal of Plankton Research, a research journal with broad dissemination to the research community. Please see attached PDF file.

The results have been disseminated through presentations and discussions with colleagues in the Gulf of Maine observing community, through the Integrated Sentinel Monitoring Project (http://www.neracoos.org/sentinelmonitoring).

The results have also been disseminated through interviews with the media, including the Associated Press, Boston Globe, Huffinton Post, Portland Press Herald and NBC Nightly News, on 8 occassions since 2012.

Products

Books

Book Chapters

Conference Papers and Presentations

Inventions

Journals

Batchelder, H., K. Daly, C. Davis, R. Ji, M. Ohman, W. Peterson, and J. Runge. (2013). Climate impacts on animal populations and communities in coastal marine systems: towards forecasting change through mechanistic understanding of population dynamics.. *Oceanography*. 26 (4), 34-51. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fields, D. M., J. A. Runge, C. Thompson, S. Shema, R. Bjelland, A. B. Skiftesvik, and H. Browman. (2014). Infection of the planktonic copepod Calanus finmarchicus by the parasitic dinoflagellate, Blastodinium spp.: effects on grazing, respiration, fecundity, and fecal pellet production.. *Journal of Plankton Research*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Preziosi, B. M. and J. A. Runge (2014). The effect of warm temperatures on hatching success of the marine planktonic copepod, Calanus finmarchicus. *Journal of Plankton Research*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Runge, J.A., R. Ji, C. Thompson, N. Record, C. Chen, D. Vandemark, J. Salisbury and F. Maps. (2014). Persistence of Calanus finmarchicus in the western Gulf of Maine during recent extreme warming.. *Journal of Plankton Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Licenses

Other Products

Databases.

Data collected at the Wilkinson Basin Time Series Station (WBTS) have been submitted to the NSF BCO-DMO (http://www.bco-dmo.org/project/523621). BCO-DMO will ensure that these data are permanently archived at NODC.

The dataset includes the following:

- Time Series metadata: date/time, location, depth, event log

- Zooplankton species abundance and composition

- *C. finmarchicus* demographic data

- CTD and profile data

- Chlorophyll a concentrations at selected depths (size fractionated)

A quantitative subsample (1/2 split) of the plankton samples collected with the vertical ring net at WBTS is preserved in 4% formaldehyde and presently archived at the sample storage site located at the Gulf of Maine Research Institute.

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Websites

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Runge, Jeffrey	PD/PI	4
Thompson, Cameron	Technician	3

Full details of individuals who have worked on the project:

Jeffrey Albert Runge
Email: jeffrey.runge@maine.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 4

Contribution to the Project: J. Runge is project leader. He participated in the collection and analysis of data and the reporting and interpretation of results in four research articles. He supervised research associate, Cameron Thompson, who was supported in this project for collection of samples and analysis of data.

Funding Support: Salary for J. Runge was supported by the Unversity of Maine

International Collaboration: No
International Travel: No

Cameron S. Thompson
Email: cameronsthompson@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 3

Contribution to the Project: C. Thompson was responsible for the collection of data at monthly intervals at two time series stations in the Gulf of Maine, identification and enumeration of plankon samples, and analysis of data

Funding Support: No other funding suppor

International Collaboration: No
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
University of New Hampshire	Academic Institution	Durham, NH

Full details of organizations that have been involved as partners:

University of New Hampshire

The Northeast Regional Ocean Council and the Northeast Regional Association for Ocean Observing Systems are presently developing a strategy for integrated sentinel monitoring of the Northeast marine ecosystems. The network would inform researchers, managers, and the public about ecosystem vulnerabilities and impacts, and support an ecosystem-approach to management framework that promotes human and ecosystem resiliency from climate change and related stressors. This research contributes to an understanding of factors sustaining the abundance of a key species in the Gulf of Maine ecosystem and will provide information for society decisions about what and how to monitor regional ecosystems for impacts of climate change.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.